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Estimation of Sockeye and Coho Salmon Escapement in Mortensens Creek, Izembek National Wildlife Refuge, 2005

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Abstract

A fixed picket weir was operated on Mortensens Creek from 1 July to 4 October 2005. Sockeye salmon *Oncorhynchus nerka* was the most abundant species counted through the weir (*N*=21,703) followed by coho *O. kisutch* (*N*=4,162), pink *O. gorbuscha* (*N*=164), and chum salmon *O. keta* (*N*=13). Dolly Varden *Salvelinus malma* (*N*=153), Bering cisco *Coregonus laurettae* (*N*=27), and starry flounder *Platichthys stellatus* (*N*=12) were also observed at the weir. Sockeye salmon sampled at the weir were 54% female, and represented eleven age groups. Age 1.3 was estimated to be 66% of the run, age 2.3 was 17% and age 1.2 was 14%. The length for male sockeye salmon ranged from 374 to 632 mm and from 438 to 600 mm for females. Coho salmon sampled at the weir were 45% female and represented five age groups. Age 2.1 comprised 53% of the run and age 1.1 was 43%. The length coho salmon ranged from 344 to 710 mm for males and from 487 to 679 mm for females.

Introduction

The outlet of Mortensens Creek is one of the few areas where sockeye *Oncorhynchus nerka* and coho *O. kisutch* salmon are available for harvest by subsistence users from King Cove and Cold Bay. An escapement goal of 3,200 to 6,400 (Nelson and Lloyd 2001) has been established for sockeye salmon, but currently there is no goal for coho salmon. In 1999, escapement of sockeye salmon in Mortensens Creek, based on aerial survey counts, was estimated to be 3,600 fish with 1,378 sockeye salmon harvested in the subsistence and commercial fisheries (ADFG 2000). About 30% of the subsistence harvest of sockeye salmon was taken by Alaska residents living outside of Cold Bay and King Cove. Also in 1999, 279 coho salmon were harvested in the commercial and subsistence fisheries (ADFG 2000). Management of both species was based on aerial surveys of escapements, but effectiveness of these surveys was limited by dark stream bottoms, turbid water, and inclement weather. The Alaska Department of Fish and Game (ADFG) was also concerned that the lack of an in-season estimate of sockeye and coho salmon escapement into Mortensens Creek could jeopardize the continued health of these runs, as well as opportunities for subsistence and sport fishing (Arnold Shaul, ADFG, personal communication). Additionally, King Cove residents were concerned about sport fishing effects on coho salmon. The State's annual sport fish survey did not specifically estimate sport harvest for Mortensens Creek, therefore, no creel survey or harvest information was available. However, the report did provide an estimate of coho salmon sport harvest for the Cold Bay area, which primarily consists of Russell and Mortensens creeks. Average sport harvest for this area from 1996 to 1998 was 671 coho salmon (Howe et al. 1997, Howe et. al. 1998, and Howe et al. 1999).

In 2001, the U.S. Fish and Wildlife Service began operating a weir on Mortensens Creek to estimate escapement of sockeye and coho salmon (Whitton 2002 and 2003; Cornum et al. 2004, Dion 2005). These estimates have provided managers with the data to address concerns about over-harvest and help resolve the conflict between subsistence and sport users. Specific objectives of this study were:

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1. Enumerate daily passage of sockeye and coho salmon through a weir on Mortensens Creek,
2. Describe the run-timing of sockeye and coho salmon through the weir,
3. Estimate the sex and age compositions of sockeye and coho salmon such that simultaneous 90% confidence intervals have a maximum width of 0.20,
4. Estimate the mean length of sockeye and coho salmon by sex and age,
5. From objective one, determine if the abundance of sockeye and coho salmon returns in Mortensens Creek are adequate to allow subsistence fishing, and,
6. From objective one, determine if the abundance of sockeye and coho salmon returns in Mortensens Creek are adequate to allow sport fishing.

Study Area

Mortensens Creek originates in the foothills of Frosty Peak and flows north towards the town of Cold Bay, Alaska before eventually turning south and emptying into Mortensens Lagoon (Figure 1). Little hydrological information is available, but the drainage consists of several small tributaries, ponds, and a lake. Mortensens Creek supports populations of sockeye, coho, chum (*O. keta*), and pink (*O. gorbuscha*) salmon and Dolly Varden (*Salvelinus malma*).

Methods

Weir Operations

The King Salmon Fish and Wildlife Field Office installed and operated a weir on Mortensens Creek from 1 July to 4 October 2005. The weir was constructed of 2 m aluminum pickets with 2 cm spacing between each picket. Each panel had a minimum of three cross pieces that were welded to the pickets. Weir panels were supported by fence posts and an 8 mm diameter galvanized aircraft cable stretched across the stream. The supporting cable was anchored to the stream banks using “dead men” buried vertically at a depth that allowed the cable to be suspended just above the water surface. Weir panels were hooked together and placed across the channel. The tops of the panels were wired to the supporting cable. The continuous panel was tilted downstream in relation to the stream bed to shunt debris to the water surface, thereby maintaining free-flow of water through the pickets. A permeable textile cloth was placed under the weir to prevent undercutting. A fyke was installed in the weir, leading to an upstream migrant holding pen (trap box). The entire weir was inspected, cleaned, and maintained daily to insure integrity.

In 2004, the weir was modified from previous years to include a fish passage chute and underwater video camera. This modification facilitated fish passage and reduced the number of fish handled at the weir. The video monitoring system consisted of an Applied Microvideo (model 10) underwater video camera that was mounted inside a sealed aluminum box with a glass viewing panel. The inside of the video box was filled with filtered stream water treated with algaecide. The camera box was attached to a fish passage chute that provided a controlled lighting environment to prevent fluctuations in light from external conditions. The distance between the camera lens and the glass window provided separation between fish and the camera lens. In turbid water, image quality is maintained because the majority of the distance between fish and the lens is within the filtered water contained in the camera box. In 2005, video images from the underwater camera were recorded using a Sanyo DSR 3000 video recorder. Motion

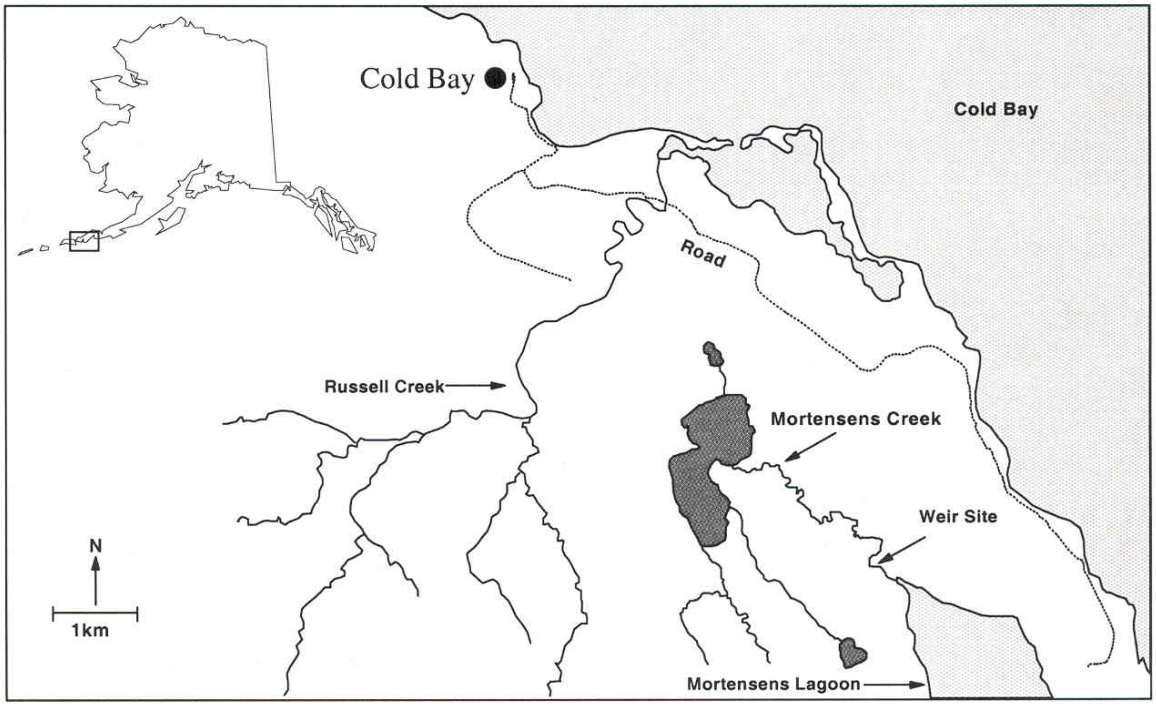

Figure 1. Mortensens Creek weir location, Izembek National Wildlife Refuge, Alaska.

detection hardware and software were used to eliminate blank footage for later counting and identification.

In 2005, several modifications were made to the camera box and fish passage chute to improve image quality in turbid water. The camera box was painted white to enhance light reflection. A finer filter was used to filter the water inside the camera box. Adjustable wide-angle halogen lights were modified with articulated arms and installed inside the camera box to aim and secure the lights with more ease and precision. A baffle was placed inside the passage chute to force fish closer to the glass to improve image quality. A wind generator was installed to generate more power to operate the video 24 hours per day.

A Hobo® temperature data logger was installed at the weir to monitor water temperatures. Water temperature was recorded every two hours and summarized as daily maximum, minimum, and mean.

Biological Data

Sockeye and coho salmon age, sex, and length (ASL) data were collected using a temporally stratified sampling design (Cochran 1977), with statistical weeks defining strata. Sockeye and coho salmon were sampled most weeks for ASL information, and to the extent logistically feasible, the sample was collected uniformly throughout each week (Sunday through Saturday). To avoid potential bias caused by the selection or capture of individual fish, all sockeye and coho salmon within the trap box were included in the sample, even if the target number of fish was exceeded. Weir passage was stratified into statistical weeks prior to sampling and was modified for analysis following the field season to account for escapement during weeks when few or no salmon were sampled (Table 1). Sockeye and coho salmon were sampled primarily during high tides. During other times of the day, water depth often prevented upstream migration.

Samples for ASL were collected using a dip net to remove fish from the holding pen. Fish were sampled at least once a day or more frequently as the number of fish moving through the weir increased. Sockeye and coho salmon were measured from mid-eye to tail fork, identified to sex using secondary sexual characteristics, and had scales collected for age analysis. One scale from sockeye salmon and three scales from coho salmon were removed from the preferred area on the left side of adult salmon (Jearld 1983). Scale samples were cleaned and mounted on gummed scale cards. The ADFG in Kodiak pressed and aged the scales. Salmon ages were reported according to the European method, where the number of winters spent in fresh water and in the ocean is separated by a decimal (Koo 1962). Fish that could not be aged were dropped from age analysis and fish that could not be sexed were dropped from sex analysis.

Weekly sample size goals were established such that simultaneous 90% interval estimates of age composition for each week have maximum widths of 0.20 (Bromaghin 1993) (Table 2). Sample sizes obtained using these methods were increased to account for the expected number of unreadable scales. The sample size goal was expected to be a substantial fraction of the salmon passage during some weeks; therefore, during weeks of low salmon passage we sampled about 20% of the weekly escapement. This was still sufficient to describe the age composition and reduced the number of salmon handled at the weir. For sample size determination, major age categories were defined from previous work (Whitton 2002 and 2003; Cornum et al. 2004; Dion 2005) as ages 1.2, 1.3, 2.2, and 2.3 for sockeye and ages 1.1, 1.2, and 1.3 for coho salmon.

Table 1. Strata (time periods) used for analysis of Mortensens Creek sockeye and coho salmon biological data, 2005.

Stratum	Sockeye Salmon	Coho Salmon
1	26 Jun - 16 Jul	26 Jun - 10 Sep
2	17 Jul - 23 Jul	11 Sep - 17 Sep
3	24 Jul - 30 Jul	18 Sep - 24 Sep
4	31 Jul - 6 Aug	25 Sep - 1 Oct
5	7 Aug - 13 Aug	2 Oct - 8 Oct
6	14 Aug - 20 Aug	
7	21 Aug - 27 Aug	
8	28 Aug - 3 Sep	
9	4 Sep - 10 Sep	
10	11 Sep - 8 Oct	

Table 2. Estimated sockeye and coho salmon weekly sample size goals.

Species	Age Categories	*N*	Unreadable (%)	Adjusted *N*
Sockeye Salmon	4	121	15	139
Coho Salmon	3	109	10	120

Characteristics of sockeye and coho salmon passing through the weir were estimated using standard stratified random sampling estimators (Cochran 1977). Within a given stratum m, the proportion of species i passing the weir that are of sex j and age k (p_{ijkm}) was estimated by

$$\hat{p}_{ijkm} = \frac{n_{ijkm}}{n_{i++m}},$$

where n_{ijkm} denotes the number of fish of species i, sex j, and age k sampled during stratum m and a subscript of "+" represents summation over all possible values of the corresponding variable, e.g., n_{i++m} denotes the total number of fish of species i sampled in stratum m. The variance of $\hat{p}_{ijkm}$ was estimated by

$$\hat{v}(\hat{p}_{ijkm}) = \left(1 - \frac{n_{i++m}}{N_{i++m}}\right) \frac{\hat{p}_{ijkm}\left(1 - \hat{p}_{ijkm}\right)}{n_{i++m} - 1},$$

where N_{i++m} denotes the total number of species i fish passing the weir in stratum m. The estimated number of fish of species i, sex j, age k passing the weir in stratum m ($\hat{N}_{ijkm}$) was

$$\hat{N}_{ijkm} = N_{i++m}\,\hat{p}_{ijkm},$$

with estimated variance

$$\hat{v}(\hat{N}_{ijkm}) = N_{i++m}^{2}\,\hat{v}(\hat{p}_{ijkm}).$$

Estimates of proportions for the entire period of weir operation were computed as weighted sums of the stratum estimates

$$\hat{p}_{ijk} = \sum_{m} \left(\frac{N_{i++m}}{N_{i+++}} \right) \hat{p}_{ijkm},$$

with estimated variance

$$\hat{v}\left(\hat{p}_{ijk}\right) = \sum_{m} \left(\frac{N_{i++m}}{N_{i+++}} \right)^{2} \hat{v}\left(\hat{p}_{ijkm}\right).$$

The total number of fish in a species, sex, and age category passing the weir during the entire period of operation was estimated by

$$\hat{N}_{ijk} = \sum_{m} \hat{N}_{ijkm},$$

with estimated variance

$$\hat{v}\left(\hat{N}_{ijk}\right) = \sum_{m} \hat{v}\left(\hat{N}_{ijkm}\right).$$

If the length of fish of species *i*, sex *j*, and age *k* sampled in stratum *m* is denoted x_{ijkm}, the sample mean length of fish of species *i*, sex *j*, and age *k* within stratum *m* was calculated by

$$\bar{x}_{ijkm} = \frac{\sum x_{ijkm}}{n_{ijkm}},$$

with corresponding sample variance s^2_{ijkm} where

$$s^2_{ijkm} = \left(1 - \frac{n_{ijkm}}{\hat{N}_{ijkm}}\right) \frac{\sum \left(x_{ijkm} - \bar{x}_{ijkm}\right)^2}{n_{ijkm} - 1}.$$

The mean length of all fish of species *i*, sex *j*, and age *k* ($\hat{\bar{x}}_{ijk}$) was estimated as a weighted sum of the stratum means

$$\hat{\bar{x}}_{ijk} = \sum_{m} \left(\frac{\hat{N}_{ijkm}}{\hat{N}_{ijk}}\right) \bar{x}_{ijkm}.$$

An approximate estimator of the variance of $\hat{\bar{x}}_{ijk}$ was obtained using the delta method (Seber 1982) where

$$\hat{v}\left(\hat{\bar{x}}_{ijk}\right) = \sum_{m} \left\{ \hat{v}\left(\hat{N}_{ijkm}\right) \left[\frac{x_{ijkm}}{\sum_{x} \hat{N}_{ijkx}} - \sum_{y} \frac{\hat{N}_{ijky}}{\left(\sum_{x} \hat{N}_{ijkx}\right)^2} x_{ijky} \right]^2 + \left(\frac{\hat{N}_{ijkm}}{\sum_{x} \hat{N}_{ijkx}}\right)^2 s^2_{ijkm} \right\}.$$

Results

Weir Operations

Weir operations began 1 July and continued through 4 October 2005. High tides associated with strong southeast winds resulted in water exceeding the height of the weir (21 July, 9 and 18 September and 4 October). On 4 October, high water washed out the substrate at the center of the weir. Since the entire weir would have needed to be removed and reinforced in order to maintain the integrity of the weir, it was removed on 5 October. The power failed on 26 July and 3 August. The DVR did not allow file review or record fish passage on 14 and 22 August and 10, 15, and 16 September. The motion detection was not triggered by every fish on 7 August and 4 September and the lights lost power on 6 September. On those days, it is likely that some fish may have passed upstream of the weir without being counted. The underwater video was turned off on 2 October because of debris in the camera box and fish were passed through the trap box for conventional counting.

Sockeye salmon were the most abundant species counted through the weir (*N*=21,703) followed by coho (*N*=4,162), pink (*N*=164), and chum salmon (*N*=13) (Tables 3 and 4, Appendix A). Dolly Varden (*N*=153), Bering cisco *Coregonus laurettae* (*N*=27) and starry flounder *Platichthys stellatus* (*N*=12) were also observed at the weir. Sockeye salmon were counted at the weir from 2 July to 29 September 2005 with a peak of 3,989 fish, or 18% of the total run, passing the weir on 1 August (Figure 2; Appendix A). Coho salmon were counted at the weir from 24 August to 3 October with a peak of 900 fish, or 22% of the total run, passing the weir on 9 September (Figure 2; Appendix A).

Water temperatures peaked at the weir in mid-August 2005 with a maximum temperature of 19.4^{o}C recorded on 22 August (Appendix B). Temperatures fluctuated between 11 and 17^{o}C, from mid-July to mid-August, between 5 and 19^{o}C during the last two weeks of August and then gradually decreased until the data logger was removed on 4 October.

Biological Data

Age, sex, and length data were collected from 1,134 sockeye salmon. Of these fish, 191 (17%) could not be aged because of illegible or regenerated scales and four could not be sexed using secondary sexual characteristics. Eleven age classes were identified from scales collected in 2005. The majority of the run consisted of age 1.2, 1.3 and 2.3 fish (Table 5). The estimated sex composition per stratum varied from 42% females in stratum 3 to 64% females in stratum 1 (Table 3). Females comprised 54% of the total sampled for the season. Sockeye salmon lengths ranged from 438 to 600 mm for females and 374 to 632 mm for males (Table 6).

Age, sex, and length data were collected from 397 coho salmon and 21 (5%) could not be aged because of illegible or regenerated scales. Five age classes were determined from coho salmon scales collected in 2005. The majority of the run consisted of age 1.1 and 2.1 fish (Table 7). The estimated sex composition per stratum varied from 38% females in stratum 2 to 64% females in stratum 5 (Table 4). Females comprised 45% of the total sampled for the season. Coho salmon lengths ranged from 330 to 679 mm for females and 344 to 710 mm for males (Table 8).

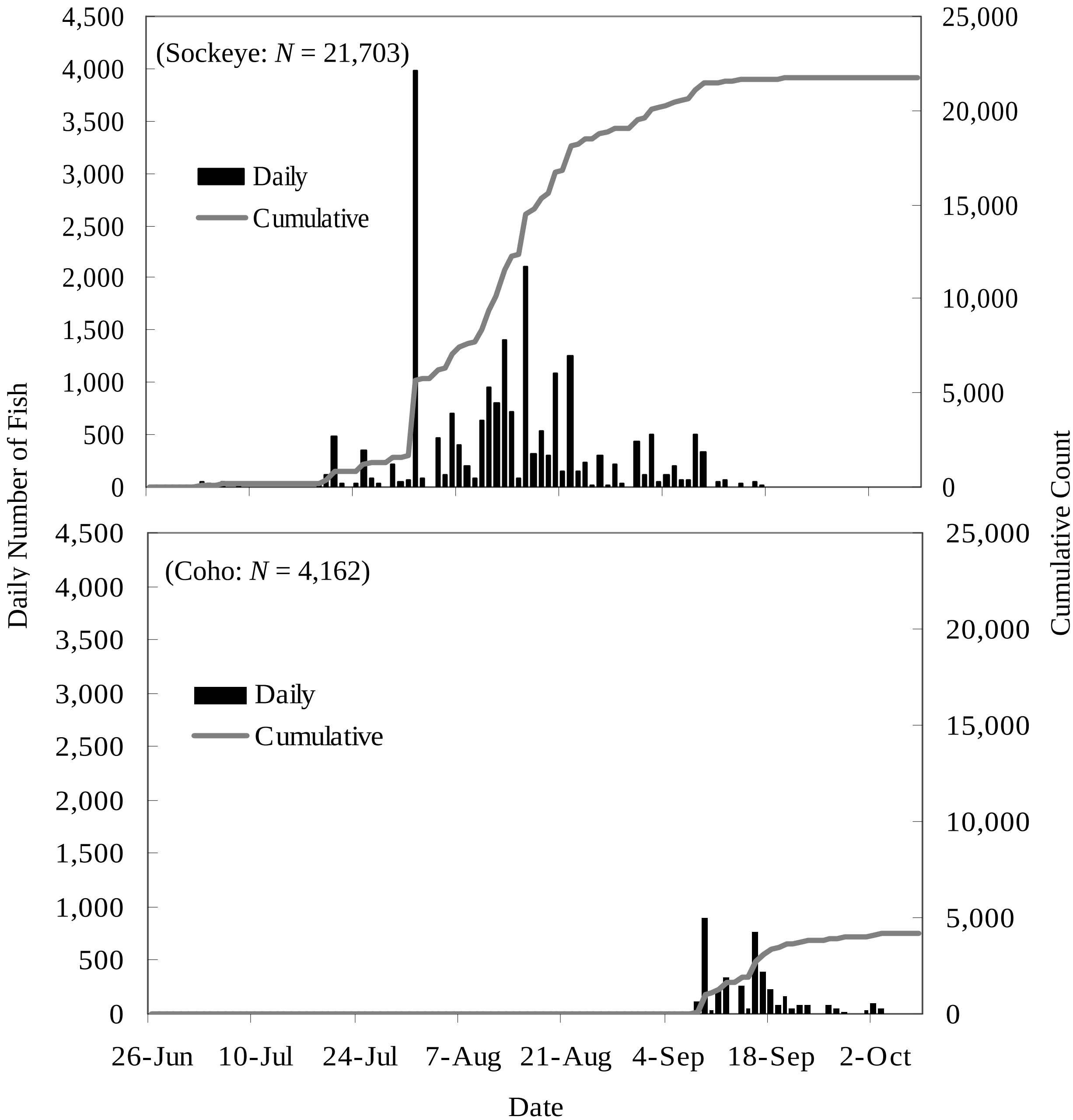

Figure 2. Sockeye and coho salmon daily and cumulative escapement counts, Mortensens Creek weir, 2005.

Table 3. Estimated sockeye salmon sex composition and escapement by stratum, Mortensens Creek weir, 2005.

Stratum	*N*	Female (%)	Male (%)	SE (%)	Escapement
1	47	64	36	6.1	183
2	85	55	45	5.1	656
3	163	42	58	3.5	777
4	158	54	46	3.9	5,440
5	181	57	43	3.6	4,504
6	64	58	42	6.2	5,137
7	150	43	57	3.9	2,125
8	147	44	56	3.9	1,344
9	105	50	50	4.7	1,301
10	30	60	40	8.5	236
Total	1,130	54	46	2.0	21,703

Table 4. Estimated coho salmon sex composition and escapement by stratum, Mortensens Creek weir, 2005.

Stratum	*N*	Female (%)	Male (%)	SE (%)	Escapement
1	75	45	55	5.6	1,071
2	122	38	62	4.3	2,036
3	128	55	45	4.0	709
4	47	62	38	6.2	187
5	25	64	36	9.0	159
Total	397	45	55	2.7	4,162

Table 5. Estimated sockeye salmon age composition by stratum, Mortensens Creek weir, 2005.

	Age Class				
	0.3	1.2	1.3	2.2	2.3
			Stratum 1		
%	10	8	49	3	28
SE	4.4	3.8	7.2	2.3	6.5
N	4	3	19	1	11
			Stratum 2		
%	0	5	73	1	19
SE	-	2.5	4.9	1.3	4.3
N	0	4	54	1	14
			Stratum 3		
%	2	7	72	1	16
SE	1.1	2.0	3.4	0.9	2.8
N	3	10	101	2	22
			Stratum 4		
%	3	5	74	1	17
SE	1.5	1.9	3.8	0.8	3.2
N	4	7	97	1	22
			Stratum 5		
%	3	6	64	4	23
SE	1.5	2.0	4.1	1.6	3.6
N	4	8	86	5	31
			Stratum 6		
%	5	12	62	0	21
SE	2.9	4.3	6.4	-	5.3
N	3	7	36	0	12
			Stratum 7		
%	4	13	65	5	12
SE	1.6	2.9	4.1	1.8	2.8
N	5	17	84	6	16
			Stratum 8		
%	6	31	56	2	5
SE	2.0	4.0	4.2	1.1	1.8
N	7	39	70	2	6
			Stratum 9		
%	6	33	60	1	0
SE	2.5	4.9	5.1	1.1	0.0
N	5	28	52	1	0
			Stratum 10		
%	4	27	50	4	12
SE	3.6	8.4	9.4	3.6	6.0
N	1	7	13	1	3
			Total[a]		
%	4	11	66	2	17
SE	0.9	1.3	2.1	0.4	1.7
N	36	130	612	20	137

[a]Total number sampled does not include ages 0.2, 0.4, 1.1, 1.4, 2.4, 3.3 (*N*=8) because they constituted less than 1% of the sample.

Table 6. Sockeye salmon mean, minimum, and maximum length (mm) by age class, Mortensens Creek weir, 2005.

	Age Class				
Length	0.3	1.2	1.3	2.2	2.3
			Female		
Mean	564	504	556	520	557
SE	10.3	11.5	7.9	10.2	8.2
Min	535	438	470	474	473
Max	590	587	600	550	600
N	14	58	318	10	68
			Male		
Mean	585	538	581	511	588
SE	10.3	15.5	10.8	16.7	8.5
Min	531	428	374	425	540
Max	625	598	632	584	620
N	21	72	293	10	69
			Total[a]		
Mean	572	523	567	516	573
SE	10.1	14.7	10.6	13.1	10.8
Min	531	428	374	425	473
Max	625	598	632	584	620
N	36	130	612	20	137

[a]Total number sampled does not include ages 0.2, 1.1, 1.4, 2.4, 3.3 (*N*=8) because they constituted less than 1% of the sample.

Table 7. Estimated coho salmon age composition by stratum, Mortensens Creek weir, 2005.

	Age Class				
	1.1	2.0	2.1	3.0	3.1
			Stratum 1		
%	49	1	49	0	1
SE	5.8	1.4	5.8	-	1.4
N	34	1	34	0	1
			Stratum 2		
%	42	1	51	1	5
SE	4.5	0.8	4.5	0.8	2.0
N	49	1	59	1	6
			Stratum 3		
%	39	0	60	0	2
SE	4.1	-	4.1	-	1.1
N	47	0	72	0	2
			Stratum 4		
%	33	0	64	0	2
SE	6.2	-	6.3	-	1.9
N	15	0	29	0	1
			Stratum 5		
%	33	0	58	0	8
SE	9.1	-	9.5	-	5.3
N	8	0	14	0	2
			Total		
%	43	1	53	>1	4
SE	2.8	0.5	2.8	0.4	1.1
N	153	2	208	1	12

Table 8. Coho salmon mean, minimum, and maximum length (mm) by age class, Mortensens Creek weir, 2005.

	Age Class				
Length	1.1	2.0	2.1	3.0	3.1
			Female		
Mean	606	-	618	-	609
SE	17.7	-	17.1	-	13.3
Min	487	-	495	330	568
Max	659	-	679	-	633
N	75	-	106	1	7
			Male		
Mean	604	361	609	-	605
SE	24.2	-	27.7	-	37.4
Min	504	344	456	-	542
Max	686	381	710	-	649
N	78	2	102	-	5
			Total		
Mean	605	361	613	-	607
SE	20.8	-	23.1	-	25.9
Min	487	344	456	330	542
Max	686	381	710	-	649
N	153	2	208	1	12

Discussion

Sockeye salmon counts were higher than the previous years of operation (Whitton 2002 and 2003; Cornum et al. 2004, Dion 2005) and well exceeded the escapement goal of 3,200 to 6,400 (Table 9). Based on aerial surveys in 2005, the Alaska Department of Fish and Game estimated sockeye salmon escapement at 20,500 (Joe Dinnocenzo, ADFG, personal communication). Weir counts were similar with an estimate of 21,703.

Sockeye salmon were captured the second day after the weir was installed and since only one fish passed the weir on that date, we assumed that few sockeye salmon passed upstream prior to installation. Only two sockeye salmon passed the weir during the two weeks prior to removing the weir. It is therefore unlikely that we missed much of the late run. Undercounting was more likely a problem when the video malfunctioned or during high tides in September and October. High tides combined with high winds blowing out of the southeast caused scouring of the substrate and banks. Fish were likely to pass the weir undetected during these conditions. Lack of wind for the wind generator and breakdown of the gas generator attributed to the majority of

Table 9. Annual escapement estimates of Pacific salmon in Mortensens Creek from 2001 to 2005

	Species			
Year	Sockeye	Coho	Chum	Pink
2001	4,268	5,279	21	15
2002	5,205	6,406	55	16
2003	16,804	8,184	18	40
2004	7,215	3,836	13	22
2005	21,703	4,162	13	164

power outages. The crew had some difficulty setting the motion detection to detect all fish that passed. This was corrected when the sensitivity was turned up. The crew was unable to view video from the DVR on several occasions. This was likely due to the recording settings not being set correctly or to the lights being unintentionally turned off. These conditions were less of a problem for sockeye salmon counts since all but two of the instances occurred after 1 August, the peak of the run. These conditions, however, may have attributed to lower coho salmon counts. Coho salmon counts in 2005 were higher than in 2004, but were lower than the previous 3 years (Whitton 2002 and 2003; Cornum et al. 2004, Dion 2005). No aerial surveys were conducted on coho salmon in 2005.

Visibility in Mortensens Creek is characteristically poor due to turbidity and may contribute to undercounting at the weir. The use of video monitoring equipment has enabled comprehensive counts for all species, and has removed much of the variability associated with observation conditions. Modifications to the camera box and passage chute in 2005 improved the reflection of light, and brought fish closer to the field of few, thus improving the quality of the image. Given the benefits of the video and conditions of the water at Mortensens Creek, it is recommended that video monitoring continue at the weir in 2006.

Sockeye salmon age composition was similar to 2001, 2002, and 2003, where the majority of the run consisted of age 3.1 fish (Whitton 2002 and 2003; Cornum et al. 2004). Age composition of coho salmon was similar to previous years (Whitton 2002 and 2003; Cornum et al. 2004, Dion 2005).

Sample size requirements for coho salmon exceeded the goal (5% were not aged). The sample size requirements for sockeye salmon were not met (17% were not aged); though the desired level of precision for sex and age composition was met (Appendix C). It is recommended that the sample sizes be maintained at the present levels for 2006.

While escapement numbers indicate sockeye and coho salmon returns to Mortensens Creek are adequate to allow subsistence and sport fishing while sustaining these runs, monitoring should continue for at least one more year. This will allow for better judgment of abundance trends and to obtain information on returns resulting from these escapements.

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Appendix A. Pacific salmon daily and cumulative (Cum) passage through Mortensens Creek weir, 2005.

	Sockeye		Coho		Chum		Pink	
Date	Daily	Cum	Daily	Cum	Daily	Cum	Daily	Cum
1-Jul	0	0	0	0	0	0	0	0
2-Jul	1	1	0	0	0	0	0	0
3-Jul	51	52	0	0	0	0	0	0
4-Jul	32	84	0	0	0	0	0	0
5-Jul	25	109	0	0	0	0	0	0
6-Jul	50	159	0	0	0	0	0	0
7-Jul	0	159	0	0	0	0	0	0
8-Jul	18	177	0	0	0	0	0	0
9-Jul	2	179	0	0	0	0	0	0
10-Jul	0	179	0	0	0	0	0	0
11-Jul	3	182	0	0	0	0	0	0
12-Jul	1	183	0	0	0	0	0	0
13-Jul	0	183	0	0	0	0	0	0
14-Jul	0	183	0	0	0	0	0	0
15-Jul	0	183	0	0	0	0	0	0
16-Jul	0	183	0	0	0	0	0	0
17-Jul	0	183	0	0	0	0	0	0
18-Jul	0	183	0	0	0	0	0	0
19-Jul	35	218	0	0	0	0	0	0
20-Jul	115	333	0	0	0	0	0	0
21-Jul[b]	479	812	0	0	0	0	0	0
22-Jul	27	839	0	0	0	0	1	1
23-Jul	0	839	0	0	0	0	0	1
24-Jul	31	870	0	0	0	0	0	1
25-Jul	350	1,220	0	0	0	0	0	1
26-Jul[a]	83	1,303	0	0	0	0	0	1
27-Jul	41	1,344	0	0	0	0	0	1
28-Jul	1	1,345	0	0	0	0	0	1
29-Jul	220	1,565	0	0	0	0	0	1
30-Jul	51	1,616	0	0	0	0	0	1
31-Jul	74	1,690	0	0	0	0	0	1
1-Aug	3,989	5,679	0	0	0	0	0	1
2-Aug	86	5,765	0	0	0	0	0	1
3-Aug[a]	5	5,770	0	0	0	0	0	1
4-Aug	467	6,237	0	0	0	0	0	1
5-Aug	113	6,350	0	0	0	0	0	1
6-Aug	706	7,056	0	0	1	1	0	1

Appendix A. Continued.

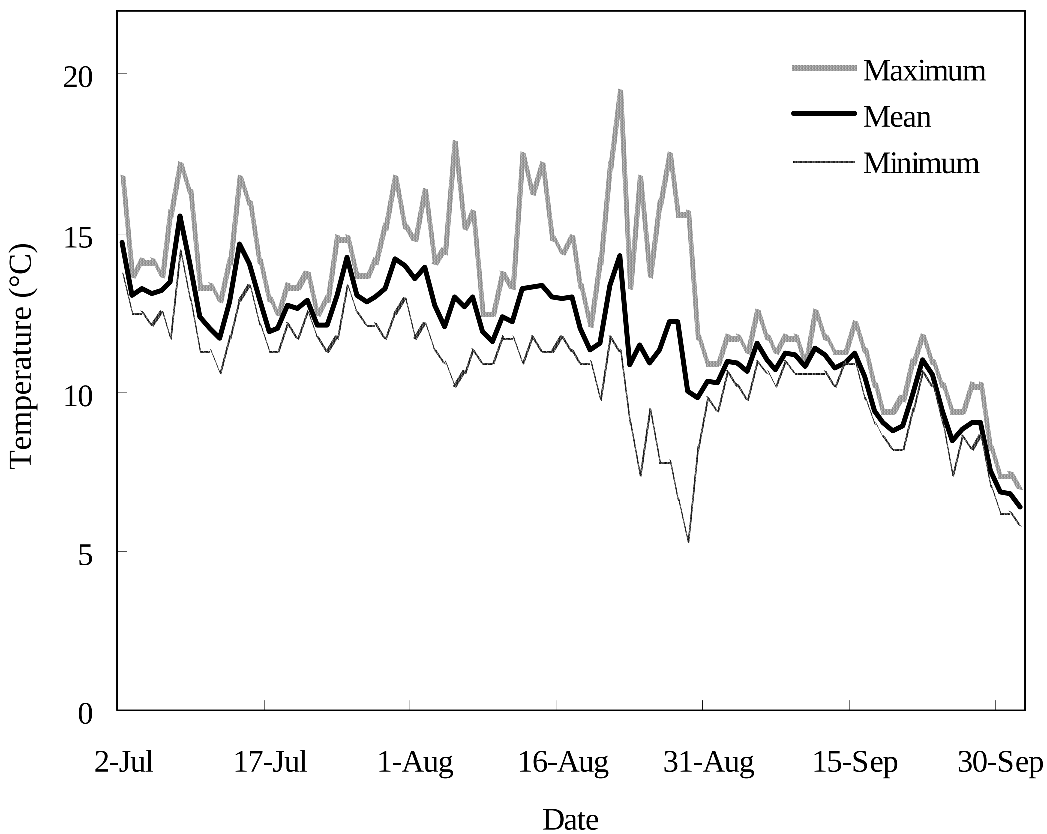
	Sockeye		Coho		Chum		Pink	
Date	Daily	Cum	Daily	Cum	Daily	Cum	Daily	Cum
7-Aug[a]	406	7,462	0	0	2	3	0	1
8-Aug	204	7,666	0	0	0	3	0	1
9-Aug	89	7,755	0	0	0	3	0	1
10-Aug	644	8,399	0	0	1	4	2	3
11-Aug	949	9,348	0	0	1	5	2	5
12-Aug	807	10,155	0	0	0	5	2	7
13-Aug	1,405	11,560	0	0	0	5	0	7
14-Aug[a]	717	12,277	0	0	0	5	0	7
15-Aug	76	12,353	0	0	1	6	1	8
16-Aug	2,105	14,458	0	0	0	6	14	22
17-Aug	317	14,775	0	0	1	7	3	25
18-Aug	537	15,312	0	0	0	7	8	33
19-Aug	298	15,610	0	0	4	11	3	36
20-Aug	1,087	16,697	0	0	1	12	14	50
21-Aug	144	16,841	0	0	0	12	7	57
22-Aug[a]	1,255	18,096	0	0	0	12	17	74
23-Aug	153	18,249	0	0	0	12	1	75
24-Aug	235	18,484	1	1	0	12	10	85
25-Aug	9	18,493	0	1	0	12	0	85
26-Aug	308	18,801	1	2	0	12	3	88
27-Aug	21	18,822	0	2	0	12	1	89
28-Aug	215	19,037	0	2	0	12	2	91
29-Aug	27	19,064	0	2	0	12	13	104
30-Aug	5	19,069	0	2	0	12	2	106
31-Aug	436	19,505	0	2	0	12	2	108
1-Sep	116	19,621	0	2	0	12	5	113
2-Sep	497	20,118	3	5	0	12	5	118
3-Sep	48	20,166	0	5	0	12	2	120
4-Sep[a]	115	20,281	2	7	0	12	7	127
5-Sep	198	20,479	2	9	0	12	2	129
6-Sep[a]	74	20,553	13	22	0	12	7	136
7-Sep	71	20,624	2	24	0	12	3	139
8-Sep	497	21,121	111	135	1	13	3	142
9-Sep[b]	339	21,460	900	1,035	0	13	9	151
10-Sep[a]	7	21,467	36	1,071	0	13	3	154
11-Sep	45	21,512	228	1,299	0	13	8	162
12-Sep	59	21,571	346	1,645	0	13	1	163
13-Sep	0	21,571	4	1,649	0	13	0	163
14-Sep	40	21,611	260	1,909	0	13	0	163

Appendix A. Continued.

Date	Sockeye		Coho		Chum		Pink	
	Daily	Cum	Daily	Cum	Daily	Cum	Daily	Cum
15-Sep[a]	5	21,616	42	1,951	0	13	0	163
16-Sep[a]	50	21,666	771	2,722	0	13	0	163
17-Sep	25	21,691	385	3,107	0	13	1	164
18-Sep[b]	4	21,695	236	3,343	0	13	0	164
19-Sep	3	21,698	86	3,429	0	13	0	164
20-Sep	3	21,701	167	3,596	0	13	0	164
21-Sep	0	21,701	55	3,651	0	13	0	164
22-Sep	0	21,701	80	3,731	0	13	0	164
23-Sep	0	21,701	84	3,815	0	13	0	164
24-Sep	0	21,701	1	3,816	0	13	0	164
25-Sep	0	21,701	1	3,817	0	13	0	164
26-Sep	0	21,701	88	3,905	0	13	0	164
27-Sep	0	21,701	48	3,953	0	13	0	164
28-Sep	1	21,702	13	3,966	0	13	0	164
29-Sep	1	21,703	0	3,966	0	13	0	164
30-Sep	0	21,703	1	3,967	0	13	0	164
1-Oct	0	21,703	36	4,003	0	13	0	164
2-Oct[a]	0	21,703	103	4,106	0	13	0	164
3-Oct[a]	0	21,703	56	4,162	0	13	0	164
4-Oct[ab]	0	21,703	0	4,162	0	13	0	164
5-Oct	0	21,703	0	4,162	0	13	0	164
6-Oct	0	21,703	0	4,162	0	13	0	164
7-Oct	0	21,703	0	4,162	0	13	0	164
8-Oct	0	21,703	0	4,162	0	13	0	164
Total	21,703		4,162		13		164	

[a]May be partial count due to video system difficulties.
[b]May be a partial count due to high tide-wind event.

Appendix B. Daily mean, minimum, and maximum water temperatures in Mortensens Creek during 2005.



Appendix C. Sockeye salmon sample size and confidence interval (CI) by age class and gender, Mortensens Creek weir, 2005.

	Age Class[a]					Gender
	0.3	1.2	1.3	2.2	2.3	
N	36	130	612	20	137	1,130
SE	0.9	1.3	2.1	0.4	1.7	2.0
CI	0.01	0.02	0.03	0.01	0.03	0.03

[a]Total number sampled does not include ages 0.2, 0.4, 1.1, 1.4, and 2.4 (*N*=8) because they were less than 1% of the sample.